Research Paper

Volume : 4 | Issue : 5 | May 2015 • ISSN No 2277 - 8179

Experimental Study on Properties of Ternary Blended self Compacting Concrete Using Quarry Dust as sand Replacement

Engineering

KEYWORDS : Self Compacting Concrete, Quarry dust, Ternary blends, Metakaolin and Fly ash.

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ABSTRACT

Self compacting concrete (SCC), which flows under its own weight and does not require any external vibration for compaction has revolutionized concrete placement. It is highly workable concrete that can flow under its own weight through restricted sections without segregation and bleeding.

Several admixtures have been developed to improve the strength and workability properties of concrete. Of all admixtures used in concrete, Metakaolin occupies a special position for quite a few reasons. The improvement of durability, resistance to chloride, sulphate, freezing and thawing, alkali silica reaction, frost attack, increase in compressive strength, reduces the permeability and bleeding. Quarry dust, a by-product from the crushing process during quarrying activities is one of such materials. Granite fines or rock dust is a by-product obtained during crushing of granite rocks and is also called quarry dust. In recent days there were also been many attempts to use Fly Ash, an industrial by product as partial replacement for cement to have higher workability, long term strength and to make the concrete more economically available. The present experiment is carried out to investigate the fresh and hardened properties of ternary blended self compacting concrete with 10% of Metakaolin and 30% of fly ash by weight of cement as partial replacement of cement and addition of 0%, 20%, 40% and 60%of Quarry dust as fine replacement.

INTRODUCTION

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of SCC ensures a high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier demoulding and faster use of elements and structures.

Two important properties specific to SCC in its plastic state are its flowability and stability. The high flowability of SCC is generally attained by using high rangewater- reducing (HRWR) admixtures and not by adding extra mixing water. The stability or resistance to segregation of the plastic concrete mixture is attained by increasing the total quantity of fines in the concrete and/or by using admixtures that modify the viscosity of the mixture.

While SCC mixtures have been successfully produced with 1½ inch (38 mm) aggregate, it is easier to design and control with smaller size aggregate. Control of aggregate moisture content is also critical to producing a good mixture. SCC mixtures typically have a higher paste volume, less coarse aggregate and higher sand-coarse aggregate ratio than typical concrete mixtures. The powdered materials that can be added are Fly ash, Silica fume, Metakaolin, Lime stone powder, Glass filler and Quartzite filler.

This research was implemented to develop and to determine the properties of Self Compacting Concrete (SCC) by using fly-ash and metakaolin as cement replacement with Quarry dust as River sand replacement.

Figure 1: Self Compacting concrete

EXPERIMENTAL PROGRAMME

In the present experiment programme, standard cubes (150x150x150mm), standard beams (100x100x500 mm),standard cylinders (150mmØ, height 300mm) were casted and tested for finding the Compressive strength, Flexure strength and Split Tensile strength properties of Plain Self Compacting Concrete and Ternary Blended Self Compacting Concrete.

Tests on fresh properties of concrete like slump flow, V-funnel, L –box were performed before casting the specimens and later tested for Compression, Flexural and split tensile strengths at the ages of 7 and 28 days.

Figure 2: Compression strength testing

Figure 3: Split tensile strength test

Figure 4: Flexural strength testing

Table 1: Compressive Strength of Various Concrete Mixtures with Constant flyash and Different Percentage of metakaolin at 7 and 28 days curing

S.No.	Mix ID	Compressive Strength (MPa)	
		7 days	28 days
1	F30MK0	35.5	49.81
2	F30MK6	36.2	50.2
3	F30MK8	37.5	51.4
4	F30MK10	38.7	52.6
5	F30MK12	37.1	50.9
6	F30MK15	35.9	49.1

Table2: Compressive Strength of ternary blended SCC Mixtures with various Percentage replacement of quarry dust at Different Ages.

S.No.	%REPLACEMENT OF QUARRY DUST	Compressive Strength (MPa)	
		7 days	28 days
1	OPSCC	34.65	49.2
2	F30MK10Q0	31.41	48.15
3	F30MK10Q20	29.52	47.55
4	F30MK10Q40	28.88	46.11
5	F30MK10Q60	26.45	44.1

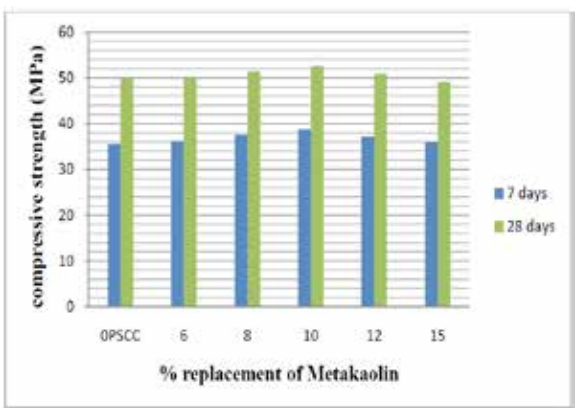
Table3: Flexural Strength of ternary blended SCC Mixtures with Various Percentage replacement of quarry dust at 28 days curing.

S.No.	Mix ID	Flexure Strength (MPa)
1	OPSCC	6.97
2	F30MK10Q0	6.94
3	F30MK10Q20	6.88
4	F30MK10Q40	6.84
5	F30MK10Q60	6.81

Table 4: Split Tensile Strength of ternary blended SCC Mixtures with Various Percentage replacement of quarry dust at 28 days curing.

S.No.	Mix ID	Split Tensile Strength (MPa)
1	OPSCC	4.96
2	F30MK10Q0	4.88
3	F30MK10Q20	4.56
4	F30MK10Q40	4.17
5	F30MK10Q60	3.94

GRAPH 1: Compressive Strength Vs % Replacement of Metakaolin with constant % of Flyash (30%)



GRAPH 2: Compressive Strength Vs Age of Mixes with Different Percentage Replacements of quarry dust.

CASE STUDY

In the present study, Admixtures like Flyash, Metakaolin and Quarry dust are replaced and measured to know the compressive strength of concrete.

The present experiment is carried out to investigate the fresh and hardened properties of ternary blended self compacting concrete with 10% of Metakaolin and 30% of fly ash by weight of cement as partial replacement of cement and addition of 0%, 20%, 40% and 60%of Quarry dust as fine replacement at the ages of 7and 28 days.

CONCLUSIONS

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Optimum percentage of SCC mix containing Metakaolin and Fly ash as partial replacement of cement was found to be 10% and 30% respectively.

The use of Metakaolin along with Flyash as partial replacement of cement enhances the properties of fresh and hardened SCC mixes.

There is a slight improvement in properties of fresh ternary blended SCC with Quarry dust as sand replacement up to 40% after that there is decrease in the properties. Replacement of river sand with quarry dust ranging from 0% to 60% decreases the compressive strength. It decreased as the % replacement of quarry dust is increased from 0% to 60% at the age of 28 days when compared with OPSCC. The optimum usage of Quarry dust is 40% with respect to self compactibility and strength of SCC. The combination of Quarry Dust with Fly Ash and Metakaolin in place of River sand & Cement respectively shall be very economical and can also help in the utility of Industrial wastes and in maintaining the ecological balance thus reducing the consumption of Cement and River sand.

SCOPE FOR FURTHER INVESTIGATIONS

Further research can be carried out to study the Flexural strength of concrete with partial replacement of different mineral admixtures like GGBS, rice husk etc along with Flyash or Metakaolin, with replacement of quarry dust.

Research on various mechanical properties like Shear strength, Impact strength etc can also be carried out using Metakaolin and Flyash as cement replacement and quarry dust as river sand replacement.

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